Automated Grouping of Opportunity Rover Alpha Particle X-ray Spectrometer Compositional Data

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The Alpha Particle X-ray Spectrometer (APXS) conducts high-precision in situ measurements of rocks and soils on both active NASA Mars rovers. Since 2004 the rover *Opportunity* has acquired around 440 unique APXS measurements, including a wide variety of compositions, during its 42+ kilometers traverse across several geological formations. Here we discuss an analytical comparison algorithm providing a means to cluster samples due to compositional similarity and the resulting automated classification scheme.

Due to the inherent variance of elements in the APXS data set, each element has an associated weight that is inversely proportional to the variance. Thus, the more consistent the abundance of an element in the data set, the more it contributes to the classification. All 16 elements standard to the APXS data set are considered. Careful attention is also given to the errors associated with the composition measured by the APXS - larger uncertainties reduce the weighting of the element accordingly. The comparison of two targets, i and j, generates a similarity score, S_{ij}. This score is immediately comparable to an average ratio across all elements if one assumes standard weighted uncertainty.

The algorithm facilitates the classification of APXS targets by chemistry alone - independent of target appearance and geological context which can be added later as a consistency check. For the N targets considered, a NxN hollow matrix, S, is generated where $S = S^T$. The average relation score, S_{av}, for target N_i is simply the average of column i of S. A large S_{av} is indicative of a unique sample. In such an instance any targets with a low comparison score can be classified alike. The threshold between classes requires careful consideration. Applying the algorithm to recent Marathon Valley targets indicates similarities with Burns formation and average-Mars-like rocks encountered earlier at Endeavour Crater as well as a new class of felsic rocks.